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FOREST INSECT INVESTIGATIONS

DAMAGE BY AMBROSIA BEETLES

TO SITKA SPRUCE AND OTHER HOSTS IN THE SPRUCE REPRODUCTION AREAS

OF

WASHINGTON AND OREGON.

by

J. M. Miller

Ashland, Oregon
January 24,1919

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MEMORANDA FOR DR. A. D. HOPKINS.

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DAMAGE BY AMBROSIA BEETLES

TO SITKA SPRUCE AND OTHER HOSTS IN THE SPRUCE PRODUCTION AREAS

OF WASHINGTON AND OREGON.

Summarizing Statement.

Damage by boring insects to Sitka spruce was first reported by the Spruce Production Division of the Signal Corps in May, 1918, when the matter was referred to the Forest Service at Portland, Oregon. This damage consisted of numerous small pin-holes in the sap-wood, and it was indicated this was a problem of considerable importance in the manufacture of airplane stock. As all of the available clear sap-wood which is used for wingbeam stock must be clear of minor defects, the presence of any number of these pin-holes resulted in its rejection. The loss involved about one million feet of rived spruce in the Necanicum- Clatsop district, and the same trouble had appeared in other districts of Oregon and Washington as well.

Following Dr. Hopkins memorandum of July 31, 1918, the problem was taken up from an investigative standpoint by the Pacific Slope Station of this Bureau. Mr. W. E. Glendinning was detailed to field work in the Clatsop district, and was engaged during the period from August 25th to October 25th near Clatsop on the cutting areas of the Spruce Production Division.

The data now available indicates that the attacks of ambrosia beetles, which were plentiful during April and May, subsided about the 15th of June. Determinations by Dr. Hopkins of specimens submitted indicated that the greater part of the damage from these earlier attacks was due to Xyloterus bivittatus, Kirby. The presence of another species, Gnathotrichus sulcatus, Lec. , was also evident, but the attacks of this beetle did not predominate until late in the season. During the summer months, however, attacks subsided to such a point that very little, if any, infested material was shipped out of the spruce producing areas. During this period canting of the spruce logs was discontinued, and this change in the method of logging reduced somewhat the available material for attack by the beetles, as a much larger proportion of the felled spruce was removed from the woods to the mill. During the months of August, September and October a limited number of ambrosia beetle attacks were recorded in the stumps and the slash which was left lying on the cutting area. These were composed largely of Gnathotrichus sulcatus in the spruce and hemlock. A decided

selection was shown for the hemlock wherever this host had been felled along the right of way or in construction work. By September the attacks of Platypus wilsoni were found on the areas, but these were relatively few and were confined entirely to the hemlock.

From all available data it is apparent that the ambrosia beetle problem in this region is of economic importance only during April, May and June. It is probable that the period of heavy attacks does not cover more than a month or six weeks. Methods of control, other than those suggested in Dr. Hopkins memorandum of July 31, 1918 do not at present appear feasible. If cutting were discontinued, or kept at as low a point as possible during the period of attack in May, it is apparent that very little damage will result. This point, however, will have to be considered in the light of other factors entering into the administrative features of spruce production. The Spruce Production Division is now demobilizing. It is apparent that if any spruce cutting is carried on in the spring of 1919 it will be upon an entirely different basis from that of the 1918 season.

LIFE HISTORY STUDIES.

Host Trees.

Four species of host trees were under observation in the locality covered by field work and the records of attacking species are limited as follows:

Host	Attacking species recorded.
Sitka spruce	Xyloterus bivittatus; Gnathotrichus sulcatus.
Western hemlock	Gnathotrichus sulcatus; Platypus wilsoni.
Douglas fir,	Gnathotrichus sulcatus; Xyloterus bivittatus.
Western red cedar	No ambrosia beetles noted.

Development of Broods.

During the period of observations no records were obtained which carried through the development of a brood from attack to last emergence. The individual records which we have apply to a series of broods developing from attacks which occurred in the same log at about the same time. The difficulties of securing satisfactory records of brood development are obvious. In order to obtain a brood record it

is necessary to open up the galleries and cut away the surrounding wood. This usually eliminates any further development of the brood which has been disturbed. It is doubtful if any satisfactory system of recording brood development can be developed except under laboratory conditions. Even the data obtained was in many instances confusing and difficult to interpret. For example, in a brood gallery of Gnathotrichus sulcatus , which was opened October 6th, a freshly deposited egg was found in an egg nitch alongside a series of newly formed adults. (See photo, page 19).

The brood records which were kept by Mr. Glendinning represent the only data which was available under the conditions and period of the field work. The intermittent and limited character of the attacks necessarily made the work trying and difficult. Records taken during the period of heavy attacks in the spring may possibly be of a more satisfactory character.

The following is a summary of the data obtained during the period:

Xyloterus bivittatus, Kirby.

Records extending from first eggs to last pupae, September 12 to October 24 (42 days). Spruce cants and Douglas fir log were noted which had been attacked and abandoned by beetles earlier in the season. Apparently, there may be at least two seasonal generations. Very few attacks were observed during period of records. Apparently the heavy attacks of this species occurred during the spring months, April, May and June.

Gnathotrichus sulcatus, Lec.

Records extending from larvae to maximum emergence, August 25th to October 24th (60 days) Also from first attack to first pupae, September 5 to October 25 (46 days). Spruce and Douglas fir logs were found which had been attacked and abandoned during early part of season. Possibly these are two seasonal generations.

Attacks occurring in both spruce and hemlock during period of records but apparent preference shown for latter host whenever available. As in Xyloterus the heavier attacks apparently occurred during spring months.

Platypus wilsoni, Sw.

Records extending from first attack to last attack, August 25 to October 24. The only life history stage found consisted of parent adults. Records are entirely too incomplete to draw any conclusions in regard to development.

Attacks were found only in hemlock. Parent adults extended galleries through the entire period from August 25th to October 25th without ovo-position occurring. It is probable that development will not be completed until next season. No evidence of attacks which occurred in the spring months or early summer.

Miscellaneous notes.

On the surface of the logs there does not appear to be any character which will distinguish between the work of Xyloterus and Gnathotrichus, as both produce the same sort of granular sawdust. On opening the galleries, however, the work of Xyloterus can be easily distinguished from that of Gnathotrichus by the slightly larger diameter of the galleries. The fungus which is propogated in the galleries of Xyloterus is quite black in color, while the fungus in Gnathotrichus galleries is brownish in color. The work of Platypus can at once be distinguished from that of the other two species by the shredded frass-like character of the sawdust.

The sex characters of Platypus wilsoni are apparently easily distinguished, the male being slightly smaller with excavated elytral declivity. This sex determination is only provisional, the female being identified in the field by the presence of eggs in the abdomen. No sex characters of Gnathotrichus and Xyloterus were determined in field work.

J. M. MILLER

Assistant Forest Entomologist.

Ashland, Oregon, January 24, 1919.

REPORT OF FIELD WORK IN VICINITY OF CLATSOP, OREGON,

AUGUST 25 TO OCTOBER 25, 1918.

In keeping with instructions of August 15, 1918, relative to an examination of certain timber areas in the states of Oregon and Washington, as concerned forest insect depredations, and more particularly those insects that are carrying their depredations into the Sitka spruce, that is being extensively "logged" in both of these states at the present time, the following:

Location and Period of Studies.

The area selected, as fairly representative of the entire region, as being the scene of extensive operations and affording abundant material for observation, is situated in the Lewis and Clark river basin, in the near vicinity of military camps, C, E and F, township 6, North Range 9, West of Willamette Meridian, Clatsop County, Oregon.

The examination took place between the dates of August 25th and October 25th, 1918, and extended but little beyond an observation of the activity of those insects known as "pin-hole" borers or ambrosia beetles.

From a central point- Camp E - the examinations were carried on daily in some parts of the selected area, and in a way that every part came under observation once a week.

Method of Obtaining Data.

The method adopted consisted of the establishment of stations on every part of the area, and these stations represented certain localities and were designated by capital letters, in the field and in the notes. The material directly examined was consecutively numbered from these letters or stations. The stations and numbers were increased and extended as development of attack warranted. In addition to the above, every opportunity was taken for a close observance of the felled logs that were to be found in every cutting area and on the right-of-way of several proposed railway spurs.

Logging Conditions in Sitka Spruce.

The cutting of Sitka spruce in the Lewis and Clark basin

began in March, 1918, and has been continually carried on up to the present date. At first this timber was cut in lesser quantities and rived or "canted" in the woods and only the desirable portion of the logs taken out. Later this method was abandoned and modern steam logging machinery installed. However, but little difference in the time between cutting and removal resulted from either operation. The time required to split the logs into "cants" and to skid them to landings was about offset by the period that must necessarily elapse between the felling of the timber in sufficient quantities that would permit of the installation of modern logging machinery and the removal of the logs.

The latter method is in use entirely at present and due to the use of steam donkeys with their extensive system of "leads" and cables, it is impossible to operate until such time as the "fallers" and "buckers" have finished with a considerable area and are out of the way. It will be seen that, regardless of any methods used, it is impossible to remove the felled logs from the stump within a month's time, and oftener a longer period is required before the logs can be taken to tide water.

Ambrosia Beetle attacks in Sitka Spruce.

As a result of operation in the district considerable felled Sitka spruce was in the position to take on the spring attack of the ambrosia beetles that occurred during the months of April, May and a part of June. With very few exceptions the spruce logs remaining in the woods during this time were attacked, and judging from the condition of those remaining on the ground were attacked in a way that left little room for additional broods. The attack was decidedly heavy and continued up to about a time between June 15th and July 1st. At the time of examination of this material in September it was found to be abandoned, but from an inspection of the galleries it is evident that the greater part of this work is due to the activity of what has been later identified as Xyloterus bivittatus with Gnathotrichus sp. active to an extent.

During the months of July and August the usual number of spruce logs remained in the area, but in no case were they attacked by insects of any kind until near September, when an indifferent attack by Gnathotrichus began, attacking alike the logs that had been on the ground for two months and those but recently cut. This attack was of but little importance from an economic standpoint and came to an end about October 20th.

Condition in Western Hemlock.

The cutting of right-of-way, securing bridge timber, clearing road way etc. has resulted in the falling of a considerable number of hemlock trees in the spruce areas. Very little of this timber, if any, has been removed fromtthe forest, and very few pieces have been found that have not been attacked by ambrosia beetles. Gnathotrichus sp. is generally responsible, and it is quite evident that,where an opportunity is afforded for a choice between spruce and hemlock, this beetle shows a decided preference for the hemlock, and it is also noted that the attack by Gnathotrichus on the hemlock did not subside during the months that the spruce was practically immune from attack, although it was lessened to quite a degree during this period.

About August 20th the hemlock was found to be developing a few light attacks by another ambrosia beetle, afterwards identified as Platypus, but little development occurred as a result of the work of this beetle until about October 1st, when the attack was found to be increasing, although confined to certain areas, and new attacks appeared up to about October 20th when, due to weather conditions or other factors, all ambrosia beetle flights apparently ceased.

Significance of the Situation.

Due to the locality of the July and August cutting being some distance from the scene of former operation and in a virgin forest, argument could be advanced that no opportunities had been afforded that would allow of the breeding up of a sufficient number of the insects to materially affect the felled trees in this particular area. This argument may have some foundation, but observations point to the contrary, and it in no way accounts for nor alters the fact that the logs in an equally virgin forest were decidedly and heavily attacked during the months of April, May and early June in those areas cut earlier in the season, but three miles away, and all in the same basin.

From going over the matter with a number of experienced lumbermen, who have operated in the forests of the Columbia basin for years, and from a limited observation of existing conditions it is rather apparent that the main flight and attack of the ambrosia beetle occurs in the spring and early summer months and that any subsequent attacks are secondary and probably result from the activity of a few earlier escaping broods. However, it must be admitted that this conjecture does not entirely account for the attack by Gnathotrichus in the hemlock during the entire summer season.

The one thing that would substantiate the autumn flight as being secondary is the fact that in no case where the spruce has taken up the broods of ambrosia beetles has it developed a complete attack, while in nearly every case during the spring attack no part of the surface of the logs escaped. It is found during the autumn activity that but in a few instances was more than one-fourth or one-third of the surface of the logs bored. It is also noted that for the autumn attack the operation of the insect is more generally confined to the tops and shattered trunks.

It is known that the present autumn attack has in no way seriously affected the felled timber on the cutting areas, and it is reasonable to believe that the insects will in no way damage these logs prior to the time of a general flight, that is not apt to occur before April 15, 1918.

As an opinion: In short, summing up the situation as it now appears, there is little danger of ambrosia depredations of the spruce logs between the date of June 15th and April 15th of the following spring. However, it must be considered that this opinion is given only after a limited opportunity for observation in the area that has heretofore been practically undisturbed by any lumbering operation.

OBSERVATIONS OF THE HABITS OF AMBROSIA BEETLES.

In taking up the matter of the habits and development of the ambrosia beetle from the limited observations afforded, it is fully realized that nothing very authentic can be arrived at in a way that will throw much light on the situation, beyond a few generalities that concerns their operations in this particular area, such as time of flight, time and manner of attack, etc., that have been taken up, in a small way, in the first part of this memorandum. However, from such attacks as did materialize during the period of the two months observations, the following:

Gnathotrichus sulcatus, Lec.

The attack begins by these beetles working in pairs, cutting vertical galleries into the wood of recently felled spruce, hemlock and fir logs to a depth of from one to four inches, except in some cases they have been found cutting to a greater depth in the hemlock. The depth of the galleries appear to be regulated by the thickness of the sap-wood. In no instance has this beetle been found carrying its galleries into the heart-wood of any host, and particularly in the spruce that has attained any size is it seldom found extending the vertical galleries beyond the outer sap layer.

The lateral or breeding galleries are started from the main galleries at directly right angles and are extended along the grain of the wood on either or both sides and at a depth ranging from one-half inch below the surface to the bottom of the main gallery. (See photo, page 19). The lateral galleries vary in length and appear to be cut, in order to accommodate the placing of a certain number of egg "nitches", and it is noted that where a number of laterals are cut their combined length approximately equals that of single laterals cut from adjoining verticals.

The egg nitches or cells are excavated along both sides of the lateral galleries at intervals of about one quarter of an inch and are placed in such manner that the entrance to the nitches alternate with those on the opposite side of the gallery. (See photo, page 19). It is not definitely known just when these nitches are cut, but it is only a short time prior to the depositing of the egg. The egg nitches as first cut by the parent adult beetles are but little larger than will allow for the accommodating of the egg. The enlargement of the egg nitch to the size later occupied by the pupae appears to be accomplished by the developing larvae.

The work of cutting the wood of both the vertical and lateral galleries, as well as the egg nitches, appears to be accomplished by the female, although in the case of Gnathotrichus the sex was not established, while the male follows removing the boring dust from the galleries to the outer surface.

This boring dust is cut in fine "grainy" sugar-like particles and when compared with the borings resulting from the work of the Platypus furnishes a distinct means of identification between the two. So far, no difference has been noted between the borings of this beetle and those of Xyleterus.

As near as can be determined, a period of time of approximately thirty days elapse between the attack by the parent adults and the depositing of the eggs in the nitches. The parent adult upon depositing the egg immediately seals the mouth of the egg nitch with boring dust, that has been converted into a "gummy" substance by the mixture with it of a glue, evidently secreted by itself. This sealing process effectually bars the entrance of the "black fungus" that is always present in the lateral galleries from the egg nitches, and at no time during either the incubating, larval or pupating periods is this fungus allowed to form in the cells. From ten to fifteen days elapse before incubation takes place when the larvae is formed and with little delay begins the enlargement of the cell in keeping with its development. During this enlarging process it is quite evident that the larvae lives upon the fiber of the removed wood. This assumption is borne out, first, by the fact that no ambrosia producing fungus is ever allowed to enter the larval cells; second, the presence of wood excrement that is ejected from the larval cells and placed in the lateral galleries at the entrance of the original nitches. When occasion requires the removal of the barrier at the mouth of the cell, to dispose of this excrement, apparently it is re-sealed before the enlarging process is continued.

The life of the larvae from incubation to the pupating period is apparently from 16 to 20 days. However, this data cannot be given with any degree of certainty, as it is substantiated with even less proof than can be brought to bear on the development of the earlier stages of this insect.

Due to the slight attack and general indifferent development of the broods nothing further has been learned along the line of the life history of the Gnathotrichus during the recent examination. Material containing the beetles in different stages has been shipped from the Clatsop forests to the Ashland Office in hopes that further examination may bring out additional information.

Xyloterus bivittatus, Kirby.

The habits of this beetle in its methods of attack and its development are very much the same as those of Gnathotrichus, except the Xyloterus shows more of a preference in the selection of a host, as its operations are more confined to the spruce where a like opportunity is afforded for an attack inthe hemlock. It is also noted that it has a tendency to shallower boring and that it starts its laterals from the main gallery soon after entering the wood.

During the light attack of the past autumn but little activity on the part of this beetle developed, but enough came under observation to determine that its methods of cutting galleries, excavating egg nitches and cell sealing process are much the same as the Gnathotrichus, with the exceptions noted above. As in the case of Gnathotrichus, no distinguishing features as to sex were established.

The operations of this beetle appear to be confined mainly to the spring attack, and but little opportunity was afforded to watch the development in the recent reconnaissance.

Platypus wilsoni, Sw.

This particular beetle took no great part in the attack by ambrosia beetles that occurredduring the late summer and autumn, and its operations began a full month later than either that of Gnathotrichus or Xyloterus, with one or two minor exceptions.

These beetles were found to rather center themselves in certain localities and in no case were they ever found selecting a host other than Western Hemlock. That this latter peculiarity of attack is due to the habits of Platypus is borne out by the fact that an equal amount of other material was scattered over an area of approximately five miles square, and that in those localities where the attacks took place a like amount of Sitka spruce logs remained as well as more or less Douglas fir In no instance were these latter mentioned logs molested.

In the case of the Platypus identifying features as to sex were established, (See Mr. Miller's notes) as it was also found that the female was responsible for the actual work of cutting the wood in extending the galleries. The male following and engaged in removing the boring dust to and out of the entrance to the gallery.

The method of cutting the galleries differs with this genus

as compared with the other two under observation in a way, that in the case of the Platypus the wood is cut at each side of the gallery and the fiber between is stripped or shredded off in strings corresponding in length to the width of the gallery. The wooly, fiber-like appearance of this dust or frass when accumulated at the entrance of the gallery furnishes a direct means of identification of the work of this genus due to the marked difference when it is compared with the meal-like borings of the other two in question.

It is noted in the case of the Platypus the progress made in cutting the galleries is much less rapid than that of either the Gnathotrichus or Xyloterus. That this is due to the method of excavation is reasonable to believe, but regardless of cause or reason it is quite well demonstrated that the Platypus requires about double the time to extend their galleries a given distance when compared with either of the other two.

This genus was found in no stage except that of parent adults, cutting the main vertical galleries, which had reached a maximum depth of nine inches, through the sap and well into the heart-wood of the Hemlock logs. (See photo, page 20).
No movement had been made to start the lateral galleries at the time this examination closed and consequently no chance was afforded for observation covering a time of development through the different stages.

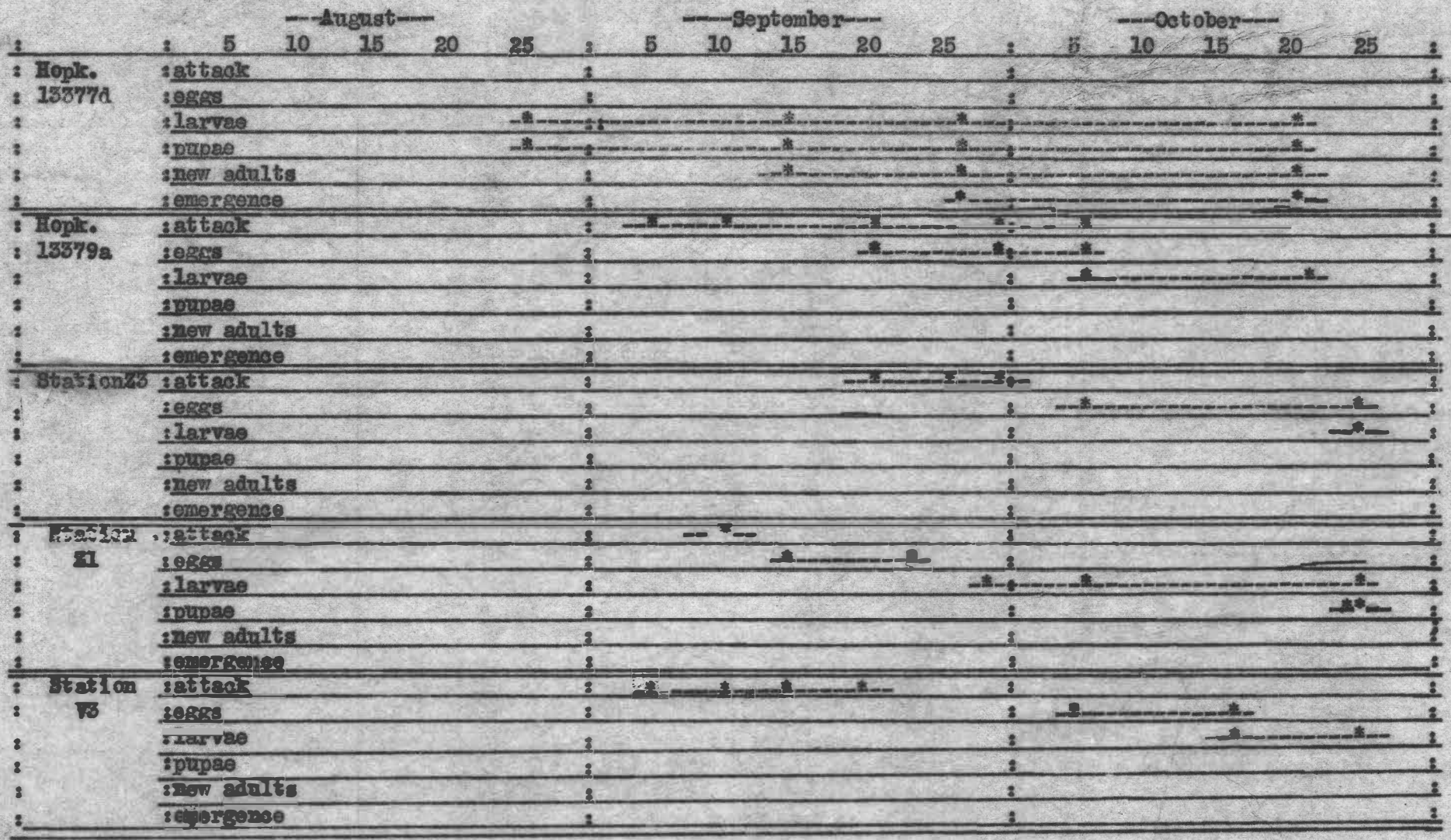
Material was secured and shipped to headquarters in Ashland, Oregon from which it is expected further data may be obtained.

Entomological Ranger.

LIFE HISTORY RECORDS.

Gnathotrichus sulcatus in Sitka spruce.

—*—indicates date of record.



LIFE HISTORY RECORDS.

Gnathotrichus sulcatus in Western Hemlock.

—*— indicates date of record.

		—August—					—September—					—October—				
		5	10	15	20	25	5	10	15	20	25	5	10	15	20	25
Station 01	attack						—*—	—*—	—*—	—*—	—*—					
	eggs									—*—	—*—	—*—				
	larvae											—*—	—*—	—*—	—*—	—*—
	pupae															
	new adults															
	emergence															
Hopk. 13376a	attack			—*—	—*—	—*—	—*—	—*—	—*—	—*—	—*—					
	eggs									—*—	—*—	—*—	—*—	—*—	—*—	—*—
	larvae														—*—	—*—
	pupae															
	new adults															
	emergence															
Hopk.	attack						—*—	—*—	—*—	—*—	—*—	—*—				
	eggs											—*—				
	larvae														—*—	
	pupae															
	new adults															
	emergence															
Station 2	attack							—*—	—*—	—*—	—*—	—*—	—*—	—*—	—*—	—*—
	eggs														—*—	—*—
	larvae															
	pupae															
	new adults		—*—													
	emergence															

LIFE HISTORY RECORDS.

Xyloterus bivittatus in Sitka spruce.

—*— indicates date of record .

		—August—					— September—					—October—				
		5	10	15	20	25	5	10	15	20	25	5	10	15	20	25
	attack						—*—	—*—		—*—						
Hopk.	eggs						—*—	—*—		—*—						
13386a	larvae									—*—	—*—	—*—	—*—	—*—	—*—	—*—
	pupae												—*—	—*—	—*—	—*—
	new adults															
	emergence															

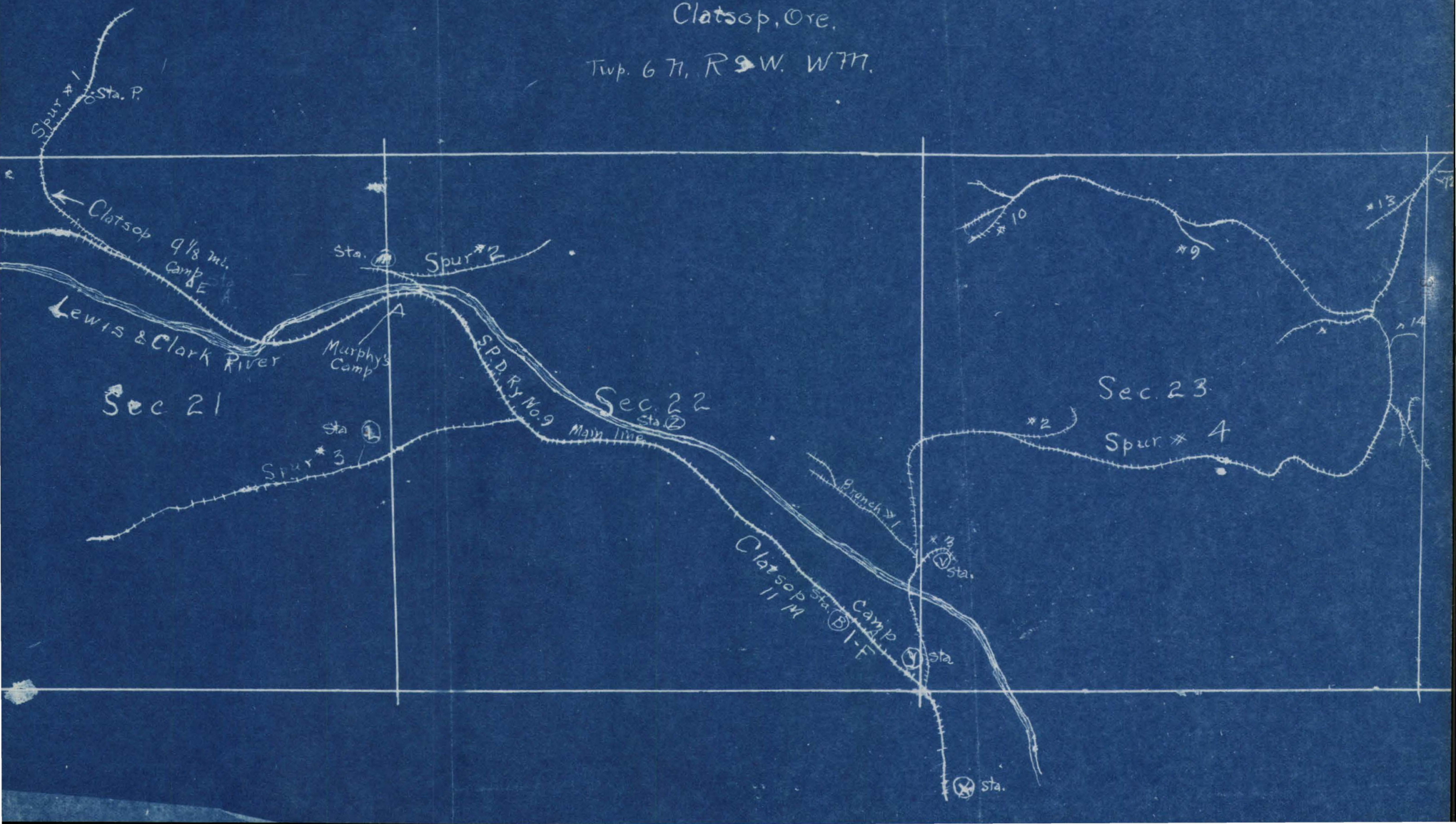
Platypus wilsoni in Western hemlock.

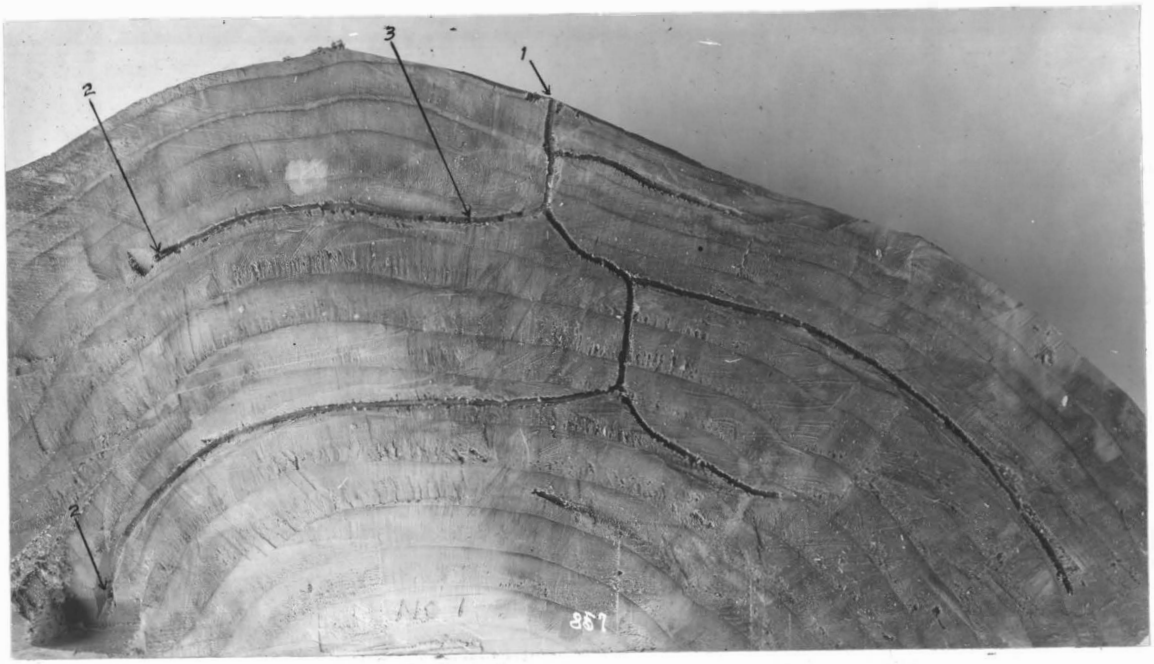
	attack			—*—	—*—	—*—	—*—	—*—		—*—	—*—	—*—	—*—	—*—	—*—	—*—
Hopk.	eggs															—
13380a	larvae															
	pupae															
	new adults														—	
	emergence															

S.P.D. Ry # 9

Clatsop, Ore.

Twp. 6 N, R 9 W. WM.



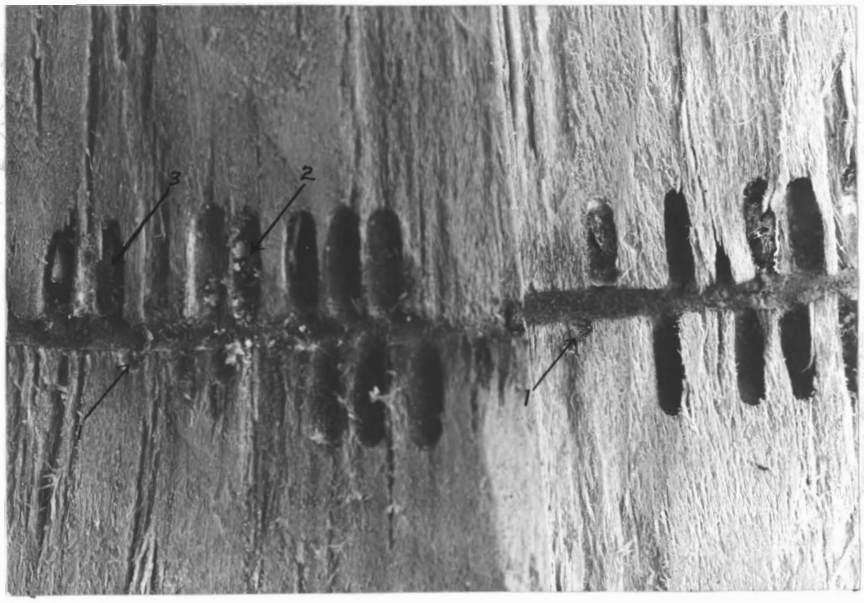


7740

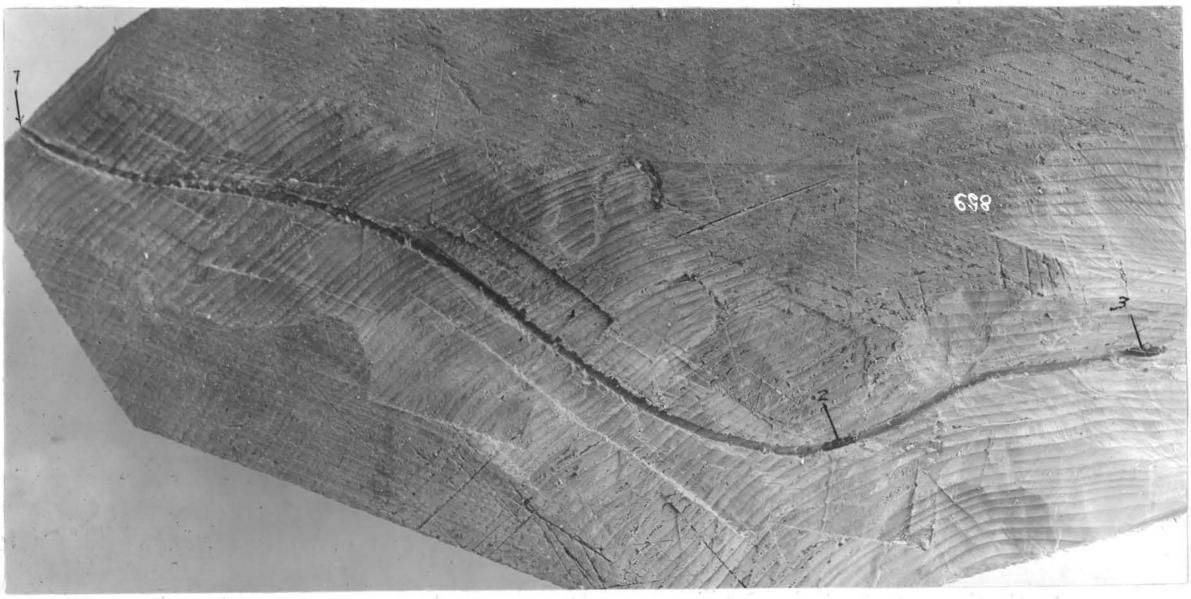
Gnathotrichus sulcatus, Lec.

Section of spruce log showing arrangement of galleries:
1. Entrance.
2. Parent adults showing position where they were found when log was uncovered.
3. Egg notches.

7739



Section of brood gallery of Gnathotrichus sulcatus.
(slightly enlarged)
1. Egg notches- these contained freshly deposited egg when gallery was opened.
2. Empty pupal cell.
3. New adult in cell.



7740

Platypus wilsoni, Sw.

Section of hemlock log showing gallery and position of parent adults when opened.

1. Entrance
2. Male
3. Female

7739

Xyletorus bivittatus, Kirby.

Section of brood gallery in spruce showing pupal cells. (slightly enlarged).

1. Cross-section of vertical gallery.
2. Pupal cells.

2241

Host Selection of Ambrosia Beetles.

Western hemlock and Sitka spruce logs felled on same date, showing preference of ambrosia beetles to hemlock (Log on the left showing places where ambrosia beetle galleries have been chipped out).

These two trees were both felled about July 15th. Attacks by Gnathotrichus sulcatus were noted on hemlock on August 28th . Attacks by Platypus wilsoni were noted September 15th and these steadily increased up to the time that observations were discontinued on October 22d.

No attacks at all occurred in the spruce logs during the entire period from July 15th to October 22d.

7737

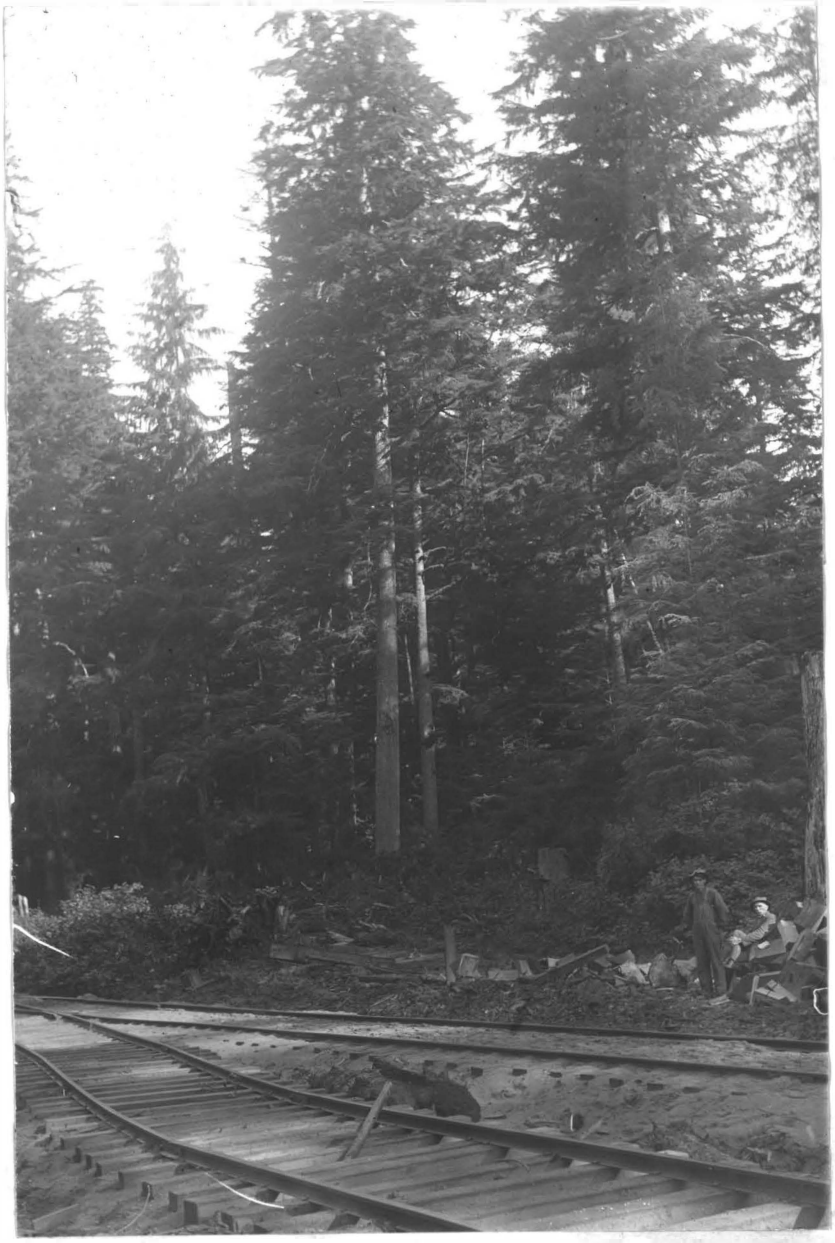
An area near Clatsop, Oregon from which the spruce has been logged by the Spruce Production Division. The hemlock is left standing. The slash is typical of this system of securing the air-plane spruce. The logs, stumps etc. furnish the breeding ground in which the most of the ambrosia beetle attacks were found during the late summer and fall.

7736 a

7736 b

Camp 1-E. Spruce Production Division. Near Clatsop, Oregon

Upper photo. Train-load of spruce logs en route to the Columbia river where they will be rafted to the S.P.D. cut up mill at Vancouver, Washington. These logs were entirely free of ambrosia beetle damage.
Lower photo,- view of Camp 1-E. Tent on extreme right was the headquarters of Entomological Ranger, Glendinning.



7736 View along the Spruce Production Division R. R.
Near Camp 6.

The forests have not been logged. Along the right of way a Douglas fir log was found which contained some attacks of Xyloterus bivittatus and Gnathotrichus sulcatus.